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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|---|-------------|----------------------|-------------------------------|------------------|
| 10/687,713 | 10/17/2003 | Kuei-Wu Huang | N1085-00184 [TSMC2002-132] | 4631 |
| 54657 | 7590 | 06/28/2006 | | EXAMINER |
| DUANE MORRIS LLP IP DEPARTMENT (TSMC) 30 SOUTH 17TH STREET PHILADELPHIA, PA 19103-4196 | | | VINH, LAN | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 1765 | |

DATE MAILED: 06/28/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

| | | |
|-----------------------------|----------------------|------------------|
| Offic Action Summary | Applicati n N . | Applicant(s) |
| | 10/687,713 | HUANG ET AL. |
| | Examin r Lan Vinh | Art Unit 1765 |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) Responsive to communication(s) filed on 05 May 2006.
- 2a) This action is **FINAL**. 2b) This action is non-final.
- 3) Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) Claim(s) 1,17 and 20-38 is/are pending in the application.
 - 4a) Of the above claim(s) 31-38 is/are withdrawn from consideration.
- 5) Claim(s) _____ is/are allowed.
- 6) Claim(s) 1,17 and 20-30 is/are rejected.
- 7) Claim(s) _____ is/are objected to.
- 8) Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) The specification is objected to by the Examiner.
- 10) The drawing(s) filed on _____ is/are: a) accepted or b) objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) All b) Some * c) None of:
 1. Certified copies of the priority documents have been received.
 2. Certified copies of the priority documents have been received in Application No. _____.
 3. Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

| | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ . |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ . | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| | 6) <input type="checkbox"/> Other: _____ . |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 17, 22-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over De Felipe et al (US 6,541,374) in view of Sudijono et al (US 2004/0092098)

De Felipe discloses a method for forming diffusion layers in a semiconductor device. The semiconductor device includes a barrier layer on a top surface of a low-k interlayer dielectric layer. The method comprises the steps of:

forming at least two copper interconnect structures within a low-k interlayer dielectric layer 103 (col 2, lines 25-55)

treating the top surface of the low-k interlayer dielectric layer to transform a thin surface layer of the low-k interlayer dielectric layer into a copper diffusion barrier (col 8, lines 5-15; fig. 2D)

Although De Felipe discloses forming a SiC barrier layer (col 2, lines 25-26), unlike the instant claimed inventions as per claims 1,17, De Felipe fails to specifically disclose treating the surface of the low-k with carbon atoms from the plasma formed from carbon dioxide/carbon-containing gas

Sudijono discloses a method for forming dual damascene comprises the step of treating the surface of a dielectric layer with plasma formed from carbon dioxide gas to form a barrier layer of SiC (col 3, paragraph 0024)

One skilled in the art at the time the invention was made would have found it obvious to modify De Felipe step of forming a SiC layer by treating the surface of the low-k with plasma formed from carbon dioxide as per Sudijono because Sudijono discloses that one process for depositing SiC includes a gas combination containing carbon dioxide (col 3, paragraph 0024)

Regarding claims 22-23, De Felipe discloses forming a dual damascene structure includes copper (col 2, lines 59-62; fig. 1G; fig. 2D)

3. Claims 20-21, 24-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over De Felipe et al (US 6,541,374) in view of Sudijono et al (US 2004/0092098) and further in view of Okada et al (US 6,583,046)

De Felipe as modified by Sudijono has been described above. Unlike the instant claimed inventions as per claims 20-21, 24, De Felipe and Sudijono fails to specifically disclose that the low-k dielectric layer is of hydrogen silsesquioxane (HSQ)/polymeric dielectric

Okada, in a method for forming dual damascene, discloses that polymer dielectric such as HSQ has been extensively studied for use as ILD in metallization processing (col 2, lines 51-53)

Thus, one skilled in the art at the time the invention was made would have found it obvious to modify De Felipe and Sudijono by using HSQ as the low- k dielectric in view of Okada teaching because Okada discloses that material such as HSQ has been considered for use as “gap-fill” between spaced-apart metal lines in view of their flowability and ability to fill very small openings (col 2, lines 54-57)

Regarding claims 25-27, De Felipe discloses applying chemical that contains silicon and nitrogen to form a nitride barrier layer on the surface of the low k while keeping the temperature of the wafer at between 100-400 degree C (col 6, lines 40-51, col 7, lines 45-50)

4. Claims 28-30 are rejected under 35 U.S.C. 103(a) as being unpatentable over De Felipe et al (US 6,541,374) in view of Sudijono et al (US 2004/0092098) and further in view of Okada et al (US 6,583,046)

De Felipe as modified by Okada has been described above. Regarding claim 30, De Felipe discloses forming a SiC barrier layer and keeping the temperature of the wafer at between 100-400 degree C (col 2, lines 25-26; col 6, lines 40-51), unlike the instant claimed inventions as per claims 28-29, De Felipe and Okada fail to specifically disclose treating the surface of the low-k with chemical contains carbon

Sudijono discloses a method for forming dual damascene comprises the step of treating the surface of a dielectric layer with carbon dioxide gas to form a barrier layer of SiC (col 3, paragraph 0024)

One skilled in the art at the time the invention was made would have found it obvious to modify De Felipe and Okada by treating the surface of the low-k with plasma formed from carbon dioxide as per Sudijono because Sudijono discloses that one process for depositing SiC includes a gas combination containing carbon dioxide (col 3, paragraph 0024)

Response to Arguments

5. Applicant's arguments filed 5/5/2006 have been fully considered but they are not persuasive.

The applicants argue that the reference of Sudijono teaches away from the claimed invention because the present claimed invention calls for a thickness of the SiC layer of preferably less than 50 angstroms while Sudijono discloses the barrier layer of SiC having a thickness of between about 200-1000 angstroms. This argument is unpersuasive because the claimed invention, as recited in amended claim 1, requires "wherein the step of treating the top surface of the low-k interlayer dielectric layer includes (a) plasma surface treatment in which the top surface of the low-k interlayer dielectric layer is bombarded by carbon atoms from the plasma formed from at least one carbon-containing gas, or (b) ion implantation using at least one carbon-containing gas. wherein the copper diffusion barrier is a layer of silicon carbide less than 50 angstroms thick" which can be interpreted that only one limitation either (a) or (b) is required by the treating step of claim 1. Since Sudijono discloses a method for forming dual damascene comprises the step of treating the surface of a dielectric layer with plasma formed from

carbon dioxide gas, which meets the requirement of limitation (a) of claim 1, it is asserted that the reference of Sudijono does not teach away from the claimed invention, as recited in amended claim 1. Thus, one skilled in the art at the time the invention was made would have found it obvious to combine DeFelipe method with Sudijono teaching to produce the claimed invention

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lan Vinh whose telephone number is 571 272 1471. The examiner can normally be reached on M-F 8:30-5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571 272 1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



LV
June 26, 2006